Geospatial Thinking of Information Professionals

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Geospatial thinking skills inform a host of library decisions including planning and managing facilities, analyzing service area populations, facility site location, library outlet and service point closures, as well as assisting users with their own geospatial needs. Geospatial thinking includes spatial cognition, spatial reasoning, and knowledge discovery. A lack of understanding of librarians' geospatial thinking called for some preliminary investigation into the geospatial thinking skills of information professionals. Findings from this pilot study's performance task indicate geospatial thinking skills improved for ten information professionals tested after some training with geospatial technologies. A summary provides recommendations on how to both improve future study of geospatial thinking and suggestions on ways to incorporate geospatial thinking into library and information science curricula.

Keywords: geospatial thinking, information literacy, geographic information systems, global positioning systems, performance task

Learning to Think Geospatially

In 2010, the ALISE Statistical Report stated that 38 LIS programs reviewed specific curriculum areas and a variety of courses were added (Wallace & Naidoo, 2010). Over a dozen courses related to literacy were either added or experimental. Geoliteracy, or spatial literacy, has emerged as a type of information literacy that librarians of all types need to understand in that geospatial data are sources of information and according to ACRL (2000) users need to be taught how to determine, access, evaluate, incorporate, and use this type of information. Therefore, many librarians who in their roles as educators need to teach these critical literacies would benefit from some training.

The skills necessary to navigate today's world of information have changed, resulting in new critical literacies that include spatial literacy as a vital skill for 21st century learners (AASL, 2007; Jenkins, 2006; Jewitt, 2008; Partnership for 21st Century Skills, 2009). Geospatial thinking and spatial literacy education have been infused in the K-12 curriculum in the United States because of the need for future knowledge workers to understand geography and how geography relates to environmental and economic issues (de Blij, 2005; National Academies Press, 2006; Pullen & Cole, 2010). Spatial thinking, as part of the STEM (science, technology, engineering, mathematics) initiatives prominent in education, promotes spatial reasoning as a way for students to learn critical thinking and decision-making skills to apply to real-world problems (de Blij, 2005; National Science Board, 2010; Pullen & Cole, 2010; Wai, Lubinski, & Benbow, 2009). As the movement to infuse geospatial thinking expands to higher education (Jo, Klein, Bednarz, & Bednarz, 2012; Lloyd, 2001; Sinton, 2009, 2010, 2011),

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there are implications for multiple types of librarians—not just those serving the K-12 community—as information professionals to understand the concepts of geospatial thinking and spatial literacy. Incorporating geographic competencies into training and courses to foster geospatial thinking across the LIS curriculum is necessary to enable librarians to assist and teach users how to use information effectively.

The increasing presence of technology and digital information in our society has necessitated changes in the LIS curriculum to address the needs of today's information professional. LIS is an ever-changing field and the curriculum to prepare future information professionals is constantly evolving to address these changes. In recent years there have been many movements implemented in the LIS curriculum to integrate new concepts into coursework to provide a relevant curriculum. Some of these efforts include topics such as Web 2.0, leadership, digital libraries, archival studies, cultural heritage, museum informatics, and information architecture (Bawden et al., 2007; Choquette, 2009; Everhart & Dresang, 2006; Latham, 2000; Long, 2011; Marty, 2011; Marty & Twidale, 2011; Spinks & Cool, 1999).

The purpose of professional education is to prepare individuals who are competent to practice in that profession and in the case of LIS this means to meet the demands of a digital society and the needs of 21st century learners. As we revisit and revise curricula to ensure that our graduates our equipped to succeed, geospatial thinking and spatial literacy mark a new need of this digital society and the topic is one that needs to be addressed within the LIS curriculum.

In 1992, Koontz addressed a need to train public librarians to think geospatially about library facility locations and discontinue the long practice of simplistic, convenient, and haphazard site selection (Koontz, 1992). Although public library openings and closures and analysis of community demographics are good examples of situations when librarians need geospatial thinking skills, there are other instances as well, such as the management of library facilities and helping users locate, retrieve, analyze, and use geospatial data. Geospatial thinking is a cognitive skill that can be used in everyday life, the workplace, and as science to structure problems, find answers, and express solutions using the properties of space. Geospatial thinking is not something innate or a genetic trait, but a skill that can be learned and taught formally to students using appropriately designed tools, technologies, and curricula (Baker & Bednarz, 2003).

Future librarians will need to analyze geographic market areas, manage library facilities, and assist and teach users (Bishop & Mandel, 2010; Johnston & Bishop, 2011). In 2006, this journal published a call to LIS education to meet the needs of future information professionals (Weimer & Reehling, 2006). However, no studies have attempted to measure librarians' geospatial thinking or discuss ways to incorporate related instruction into LIS curricula. This paper presents preliminary findings on some information professionals' geospatial thinking, provides suggestions for future study, and explores some options on how to incorporate geospatial thinking into LIS curricula.

Gratz Park Tour: Evaluating Information Professionals' Geospatial Thinking

To begin exploration of information professionals' geospatial thinking, librarians and LIS students were recruited to participate in a study involving a pretest/posttest of a scenario that included the typical variables of geospatial thinking, including perspective, dimensions, measurement, locations, relationship, and time period. The results of responses to the scenario provide preliminary findings on some information professionals' geospatial thinking. The pretest/posttest was administered prior to and immediately after librarians and LIS

students completed training on the use of geospatial technologies during a tour.

After the study's protocols were reviewed and approved by an Institutional Review Board, participants for this pilot study were recruited via a posting about the tour that was distributed on state-wide academic, public, and school librarian email lists, as well as LIS student email lists. This posting asked for participants who would like to attend a tour of Gratz Park, learn history and how to use a GPS, and participate in research. The tour was open to any student and librarian interested, and twelve potential participants responded with interest in taking part in the tour. Twelve practicing librarians and LIS students participated in the tour, but only ten (five librarians and five students) signed a consent agreement and completed both the pretest and posttest.

Gratz Park is a historic neighborhood in downtown Lexington, Kentucky. Local historians developed a tour that included stops at Henry Clay's law office, a slave auction market, a stop on the underground railroad, the home of famous Civil War raider John Hunt Morgan, and the homes of many free blacks during the Civil War, including the childhood home of National Association for the Advancement of Colored People (NAACP) Memphis branch co-founder Julia Britton Hooks. The local historians created a lengthy brochure with citations for our group, but our participants were learning about the use of geospatial technologies in addition to a great deal of history.

The training-in-action included a history of geospatial technologies, terminology, and hands-on training on how to use a global positioning system (GPS) to mark waypoints along the tour route conducted by Geographic Information System Professionals (GISPs) from the Tracy Farmer Institute for Sustainability and the Environment at the University of Kentucky. The training-in-action, discussion of geospatial thinking terminology, and act of using geospatial technologies to map the historic points of their tour provided the study's participants with active exposure to learning new technologies and thinking geospatially.

A pretest/posttest design was chosen for this research since the goal was to assess the geospatial thinking abilities of librarians and LIS students both prior to and after the use of geospatial technologies (Creswell, 2008). The pretest/posttests included a scenario involving a public library opening and the participants responded to structured questions to address some of the variables of geospatial thinking, including perspective, dimensions, measurement, locations, relationship, and time period. Definitions and examples of these terms were discussed during the training-in-action. The pretest was completed directly before the tour began, and participants were given as much time as needed to complete the pretest. The posttest was provided to each participant and returned to the researchers within one week after the tour.

The scenario of both the pretest/posttest was provided as follows:

> A local public library system has received a generous donation to open a new library branch. There are several possible locations for the new branch, but the donation specified that the branch should serve children in low socio-economic areas of the county. Also, you want to avoid locations prone to flooding. What data about the space do you need to describe the situation and begin to solve the facility location problem? Describe the perspectives, dimensions, measurements, locations, relationships and time period you would need and why.

The pretests and posttests provided participants with several closed questions related to each variable of geospatial thinking and one open-ended question for suggestions on how librarians might utilize geospatial thinking in their profession. After submitting their signed consent agreement and completing the pretest, each participant was given a GPS unit

and received the training-in-action from the Tracy Farmer Institute's *Information Technology through Community–Based Natural Resources Program for Students and Teachers* Project Team.

After the tour, participants were sent a follow up email thanking them for their participation along with the posttest to complete. Although the convenience sample of five librarians and five LIS students does not allow for generalizability, the study provides some baseline results and methodological considerations for future studies. To code the data, a rubric from the Tracy Farmer *Institute's Information Technology through Community Based Natural Resources Program for Students and Teachers* was adapted.

To increase the reliability of the coding, intercoder reliability testing was conducted. The data were coded by two coders after they received training on the topic area and rubric. It is recommended to utilize 10% of the dataset for intercoder reliability testing; in this case 30% (n = 6) of the viable twenty pretests and posttests were utilized (Neuendorf, 2002). The completed coding was compared and utilized the percent agreement formula (Neuendorf, 2002). The researchers found an acceptable agreement of 80.5% in the coding of the participant responses by the two coders.

The entire set of pretest and posttests was then coded according to the rubric. Scoring in the rubric included a scale from one to five for each variable. One point was awarded for every mention of an example for each geospatial thinking variable and two points were awarded for every mention of an example for a geospatial thinking variable and why it was important. For example, one pretest question was "describe the *locations* you would need to know and why?" An answer that listed a location without a reason received only one point (e.g., *other libraries in the area*). An answer that mentioned one location with a reason (e.g., *other libraries in the area, to avoid overlap in service areas*) or an answer that listed two locations received two points (e.g., *other libraries in the area, nearby parking*). Few librarians or students received more than three points on any variable.

The participant responses for each variable were aggregated to produce pretest and posttest student totals, librarian totals, and also a measure of change in response to variables between pretest and posttest for all. Table 1 provides the student and librarian totals scores by variable.

Both librarians and LIS students were able to list measurements and locations required to solve the library scenario problem. These geospatial thinking variables were likely learned in quantitative portions of K-12 and undergraduate coursework. Both also identified the time period variable as valuable to solving the scenario, but librarians mentioned it twice as much as LIS students. Time may be a more important variable for the librarians, who are seasoned with experience and know the value of historical data. However, there were obvious difficulties amongst all participants to define and provide examples of perspectives, dimensions, and relationships in a geographic context. Part of geospatial thinking includes spatial reasoning and the perspectives (e.g., inside, outside, close-up, bird's eye), dimensions (e.g., 2D length, 3D depth, motion, time), and relationships (e.g., overlay, union, intersection of places, people, and things). These spatial reasoning topics may not be covered in LIS curricula.

Table 1. Pretest and Posttest Variable Totals.

	Student Totals		**Librarian Totals**		**Totals**	
Variables	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Perspective	2	6	3	5	**5**	**11**
Dimensions	6	6	9	10	**15**	**16**
Measurement	11	8	9	15	**20**	**23**
Locations	8	10	11	14	**19**	**24**
Relationship	5	2	8	10	**13**	**12**
Time period	6	6	12	14	**18**	**20**

Table 2. Pretest and Posttest Average Change by Variable.

Variables	Average Student's Change (Students' Total Change)	Average Librarian's Change (Librarians' Total Change)	Average Participant's Change (Total Change)
Perspective	**0.8 (4)**	0.4 (2)	**0.6 (6)**
Dimensions	0.0 (0)	0.2 (1)	0.1 (1)
Measurement	**–0.6 (–3)**	**1.2 (6)**	**0.3 (3)**
Locations	**0.4 (2)**	**0.6 (3)**	**0.5 (5)**
Relationship	–0.6 (–3)	0.4 (2)	–0.1 (–1)
Time period	0.0 (0)	0.4 (2)	0.2 (2)

In comparing the pretest/posttest responses after the training, the change may indicate that similar fieldwork with geospatial technologies may improve a few of the geospatial thinking variables for information professionals. The data show that perhaps by marking waypoints and active hands-on learning librarians and students list more locations on average (0.6) and measurements (0.3) needed to address the questionnaire scenario. Also, an increase occurred on the variable perspective (0.6). This may relate to the repeated mention of perspectives being key in the use of the GPS (e.g., orientation determined the direction arrow on the tour) and in stories from the tour (e.g., the homes had very high doorways to accommodate residents getting in and out of carriages). Table 2 provides the student and librarian average change by variable.

Summary of Recommendations for Future Study and LIS Curriculum

In examining the results in relation to the pre and posttest instruments, several issues emerged for research and teaching. First, more research should be done beyond this preliminary pilot test. Greater numbers of participants and the use of qualitative methods would benefit further study. However, there are some lessons learned from this exploratory research.

GIS-related terminology (i.e. dimension, perspective, measurement) needs to be thoroughly defined for the participants. Although the terms were discussed and examples were given, perhaps participants would benefit from even more formal training. One of the most interesting findings in this aspect of the research was the lack of knowledge of even the most basic concepts of geospatial thinking. As a result, many participants left some geospatial thinking variables blank. Also, it was found that several librarians addressed internal measurements, such as linear feet of books for shelf space, and although this counted, there may need to be two questions to capture both the internal and external measurements that would relate to planning a new library facility. Future studies may also wish to select a different scenario that does not relate to such a complex task.

The lack of change that emerged in responses from the pretest to the posttest may indicate that a tour or any geospatial technologies fieldwork may not equate to a measurable change in geospatial thinking. Future research in this area would need to develop other instruction to relate directly to applicable geospatial thinking skills for information professionals. This pilot study will serve as the foundation for future studies as the researchers seek to expand this investigation to provide data to inform LIS education as programs develop curricula to meet the ever-changing needs of LIS students and the users they will be helping in the 21st Century.

Pilot study participants provided several ideas to incorporate geospatial thinking into their everyday jobs. From reconsider-

ing signage placement with new eyes to creating interactive maps, librarians and students alike had fresh ideas after the training-in-action and the tour. Planning for facilities, planning for collections, placement of displays and furniture, helping answer users' questions concerning geospatial data, are all some issues mentioned by participants that require geospatial thinking skills to solve. Some mentioned using GPS as a hook in an outreach program to get kids to participate in other library services and resources. One ambitious librarian even thought to develop a mobile app to provide a historic tour of the university similar to the North Carolina State University Libraries' WolfWalk (http://www.lib.ncsu.edu/wolfwalk/) and an LIS student thought to overlay maps of campus over time to show changes in buildings and landscape and linking oral histories to locations.

Limited exposure to geospatial thinking and geospatial technologies provided librarians and students with some understanding of why they need to have these skills, but the study has left open the question of how best to implement geospatial thinking across LIS curricula. It is possible as suggested by others in the literature to introduce special topics into existing courses. For example, strategic planning in a management class may also include a facility site location scenario. The increased importance of understanding the demographics of service areas as well as the relationship between facilities, community, and environment, should ensure geospatial thinking variables are taught in the curricula. Also, any specialized reference course may devote a week to finding and locating geospatial data. It remains unknown what geospatial thinking skills most librarians have, but increased focus in LIS curricula on the perspective, dimensions, and relationships of space may lead to more information professionals thinking spatially and making more informed decisions regarding the worlds within and outside the library walls.

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